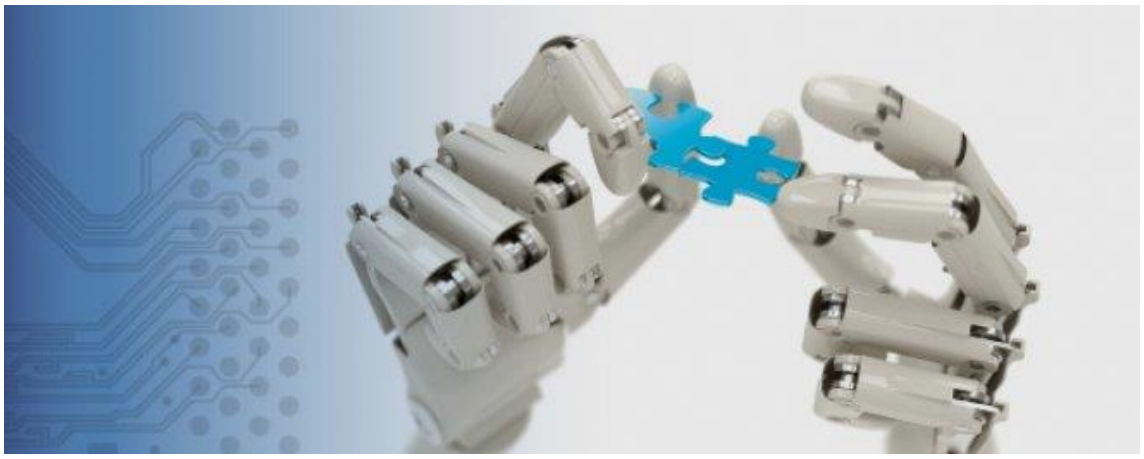
ROBOTICS MASTER

Universitat de Vic



Subject: Actuators and Controls

Session1: Mechanisms and Actuators

Exercixse 1.1: Choose a Motor

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Actuators: Motor selection

Functional requirement: DC Gear head motor capable of accelerating a 6.8Kg, two-wheel drive robot (2 motors) with wheel diameters of 10cm at a rate of 1m/s^2. Top speed required will be 1.5 m/s.

Design Parameters: Supplied Voltage = 12V; Motor size limited to an overall diameter of 5cm and an overall length of 10cm (without output shaft length)

Some help:
1. Calculate required wheel torque and RPM
2. Search DC motor manufacturers to determine availability of gear-head motors that meet the Functional Requirements and the Design Parameters.
3. Compare published specifications of the various gear-head motors to determine which will provide the best value in terms of the constraints listed above.

1. Calculate required wheel torque and RPM

Requirements:

- DC motor capable of accelerate at 6.8Kg
- Two-wheel drive robot (2 motors)
- Wheel diameters of 10cm at a rate of 1m/s^2
- Top speed required = 1.5m/s
- Supply voltage = 12VDC
- Motor size limited to an overall diameter of 5cm and an overall length of 10cm

1) Calculate the required RPM to a maximum speed of 1.5m/s

$$w = \frac{v}{r} = \frac{\frac{1500mm}{s}}{100/2} = 30\frac{rad}{s}$$

$$1\,rev = 2\pi rad\,, 1min = 60s$$

$$w = 15\left[\frac{rad}{s}\right] * \frac{60[s]}{2\pi[rad]} = \mathbf{286.48\ RPM}$$

2) Calculate the required Torque

$$T = F[N] * R[M]$$
$$F[N] = m[kg] * a[\frac{m}{s^2}]$$

With the acceleration and mass given by the exercise;
m = 6.8kg
a = 1m/s^2
But is a two-wheel robot with two motors. So the mass of the robot is divided by this two motors.
m = 6.8kg/2 = 3.4kg

$$F = 3.4 * 1 = 3.4N$$

With the calculated Force, now can be calculated the required Torque for each motor;
Wheel diametetr = 10cm
Wheel radius = 5 cm

$$T = 3.4 * \frac{5}{100} = \mathbf{0.17Nm}$$

Each motor of the system must have a maximum speed of **286.48 RPM and 0.17Nm** of torque. Motor selection according to these values.

2. Search DC motor manufacturers to determine availability of gear-head motors that meet the Functional Requirements and the Design Parameters.

Using google have been found the following DC motors manufacturers;

- Maxon
- Digikey
- Pololu
- Jameco
- MetMotors

Also used some distributor webs, such as;

- Rs-Online
- Farnell
- RobotShop
- Alibaba

3. Compare published specifications of the various gear-head motors to determine which will provide the best value in terms of the constraints listed above.

Requirements:

- Two motors
- 286.48 RPM, 0.17Nm
- Supply Voltage = 12V
- Maximum size = 50mm x 100mm
- Shaft diameter is not specified in this exercise

Selected manufacturer is Pololu, due to his extensive catalog and how easy is find a specific model using his Webpage, in which you can filter in many different criteria. Also the small design of these motors is a very relevant criteria in this selection.

Models with 12V of supply voltage with this maximum speed are very difficult to find. The following proposed motors have a high maximum velocity:

Product	Unit price USD	Quantity available	Size	Weight g	Shaft diameter mm	Free-run speed @ 12V rpm	Free-run current @ 12V mA	Stall current @ 12V mA	Stall torque @ 12V oz·in
#2821 Motor with 64 CPR Encoder for 37D mm Metal Gearmotors (No Gearbox)	24.95	30	34.5D x 46.5L mm[1]	110		11000	300	5000	5
#2827 131:1 Metal Gearmotor 37Dx73L mm with 64 CPR Encoder	39.95	27	37D x 72.5L mm[2]	235	6	80	300	5000	250
#2826 100:1 Metal Gearmotor 37Dx73L mm with 64 CPR Encoder	39.95	32	37D x 72.5L mm[2]	230	6	100	300	5000	220
#2825 70:1 Metal Gearmotor 37Dx70L mm with 64 CPR Encoder	39.95	30	37D x 70L mm[2]	225	6	150	300	5000	200
#2824 50:1 Metal Gearmotor 37Dx70L mm with 64 CPR Encoder	39.95	31	37D x 70L mm[2]	225	6	200	300	5000	170
#2823 30:1 Metal Gearmotor 37Dx68L mm with 64 CPR Encoder	39.95	20	37D x 68L mm[2]	215	6	350	300	5000	110
#2822 19:1 Metal Gearmotor 37Dx68L mm with 64 CPR Encoder	39.95	57	37D x 68L mm[2]	215	6	500	300	5000	84

Model #2823 is the best option with 12V supply voltage. But the Torque it is much higher than necessary.

https://www.pololu.com/product/2823

Another good option is to do a voltage divider, and search smallest motors with 6V of Supply Voltage. Pololu has a very good catalogue of small micro metal Gearmotors

Product	Unit price USD	Quantity available	Size	Weight g	Shaft diameter mm	Gear ratio	Free-run speed @ 6V rpm	Free-run current @ 6V mA	Stall current @ 6V mA	Stall torque @ 6V oz·in
Gearmotor MP with Extended Motor Shaft	16.95	275	10 × 12 × 26 mm[5]	9.5	3[2]	100.37:1	220	40	700	19
#2367 100:1 Micro Metal Gearmotor MP	15.95	319	10 × 12 × 26 mm[6]	9.5	3[2]	100.37:1	220	40	700	19
#2203 50:1 Micro Metal Gearmotor with Extended Motor Shaft	16.95	237	10 × 12 × 26 mm[5]	9.5	3[2]	51.45:1	250	40	360	7
#1098 50:1 Micro Metal Gearmotor	15.95	153	10 × 12 × 26 mm[6]	9.5	3[2]	51.45:1	250	40	360	7
#2380 75:1 Micro Metal Gearmotor MP with Extended Motor Shaft	16.95	158	10 × 12 × 26 mm[5]	9.5	3[2]	75.81:1	290	40	700	17
#2366 75:1 Micro Metal Gearmotor MP	15.95	235	10 × 12 × 26 mm[6]	9.5	3[2]	75.81:1	290	40	700	17
#3075 100:1 Micro Metal Gearmotor HPCB with Extended Motor Shaft	18.95	127	10 × 12 × 26 mm[6]	9.5	3[2]	100.37:1	320	120	1600	30
#3065 100:1 Micro Metal Gearmotor HPCB	17.95	254	10 × 12 × 26 mm[6]	9.5	3[2]	100.37:1	320	120	1600	30
#2214 100:1										

The selection of these small motors is more efficient for the design, it is no so oversized and the size is significantly smaller.

A good selection in this kind of 6V motors are;
Model #2203 and model #1098
https://www.pololu.com/product/1098
https://www.pololu.com/product/2203